PATENT ABSTRACTS OF JAPAN

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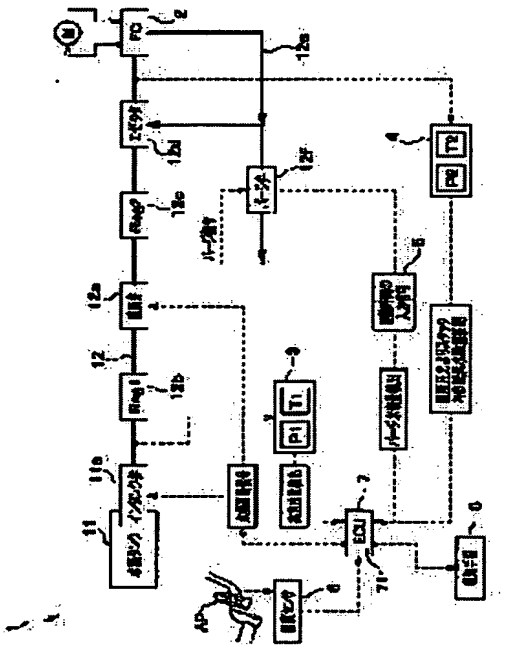
(54) FUEL SUPPLY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fuel supply device capable of precisely detecting slight gas leakage.
SOLUTION: This fuel supply device 1 calculates a pressure drop amount in a hydrogen supply passage 12 from a total amount of hydrogen equivalent to the sum of the amount of unused hydrogen discharged from a fuel cell 2 and the amount of used hydrogen consumed by the fuel cell 2 using a first sensor 3 to a third sensor 5, an opening sensor 6, and an ECU 7. If the detected pressure drop amount exceeds the calculated pressure drop amount by a predetermined value or more, it is discriminated that hydrogen leaks.



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CLAIMS

[Claim(s)]
[Claim 1] In the fuel supply system which is equipped with the hydrogen tank with which it filled up with hydrogen, and supplies hydrogen to a fuel cell through a hydrogen supply way from this hydrogen tank An amount calculation means of pressure drawdowns to compute the amount of pressure drawdowns in said hydrogen supply way from the total amount of hydrogen equivalent to the sum of the unused amount of hydrogen discharged from said fuel cell, and the amount of hydrogen consumed by generation of electrical energy of said fuel cell, It is the fuel supply system with which it has an amount detection means of pressure drawdowns to detect the amount of pressure drawdowns in said hydrogen supply way, and the detected amount of pressure drawdowns is characterized by having a hydrogen leakage decision means to judge that said hydrogen has leaked beyond the predetermined value rather than said computed amount of pressure drawdowns when large.
[Claim 2] Said unused amount of hydrogen is a fuel supply system according to claim 1 characterized by being the amount of wear hydrogen and/or the amount of purge hydrogen purged within said fuel cell.
[Claim 3] The fuel supply system according to claim 1 or 2 characterized by having an amendment means to amend said total amount of hydrogen according to the condition of the hydrogen in said hydrogen supply way.
[Claim 4] In the fuel supply system which is equipped with the fuel tank where it filled up with fuel gas, and supplies fuel gas to a gas engine through a fuel gas supply way from this fuel tank An amount detection means of pressure drawdowns to detect the amount of pressure drawdowns in said fuel gas supply way, An amendment means to amend the fuel gas consumption which said gas engine consumed according to the condition of said fuel gas, An amount calculation means of pressure drawdowns to compute the amount of pressure drawdowns in said fuel gas supply way from this amended fuel gas consumption, It is the fuel supply system characterized by equipping a preparation and said detected amount of pressure drawdowns with a gas leakage decision means to judge that said fuel gas has leaked beyond the predetermined value rather than said computed amount of pressure drawdowns when large.
[Claim 5] Said amendment means is a fuel supply system according to claim 4 characterized by amending according to the pressure and/or temperature of said fuel gas.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the fuel supply system equipped with a means to detect the leakage of fuel gas especially, about the fuel supply system which supplies fuel gas.
[0002]
[Description of the Prior Art] Conventionally, the car driven with fuel gas, such as hydrogen and compressed natural gas, is equipped with the fuel supply system which mainly consists of a tank which stores this fuel gas, and this tank with the fuel feeding pipe for supplying fuel gas to a fuel cell, an engine, etc. And as a cure against gas leakage, when gas leaks, the excess flow valve which intercepts a fuel feeding pipe is prepared in such a fuel supply system. Concretely, this excess flow valve uses that the flowing quantity of gas flow increases the inside of a fuel feeding pipe according to gas having leaked, and when a superfluous flow rate flows, it has structure equipped with the breaker style which closes a fuel feeding pipe. Moreover, there are a pressure sensor which detects the pressure of the fuel gas which flows a fuel feeding pipe as another cure against gas leakage, and a fuel supply system equipped with the latching valve which intercepts supply of fuel gas based on the detection value of this pressure sensor. Concretely, the pressure of the fuel gas which flows a fuel feeding pipe is always detected by the pressure sensor, and this fuel supply system has the structure where a latching valve is closed, if the amount of pressure drawdowns computed from this detection value becomes more than the predetermined amount of pressure drawdowns.
[0003]
[Problem(s) to be Solved by the Invention] However, with the structure equipped with an excess flow valve like before, since the setting flow rate for closing an excess flow valve was more highly set up rather than the maximum consumption of gas engines, such as a fuel cell, so that an excess flow valve might not operate at the time of the usual operation, it is difficult to detect slight gas leakage, and a breaker style might not operate. Moreover, since the amount of setting-pressure descent for closing a latching valve was more highly set up rather than the amount of pressure drawdowns corresponding to the maximum consumption, such as a fuel cell, with the structure which prepared the latching valve which intercepts supply of fuel gas based on the detection value of the pressure sensor which detects the pressure of the fuel gas which flows a fuel feeding pipe, and this pressure sensor so that a latching valve might not operate at the time of the usual operation, it was difficult to detect slight gas leakage. Moreover, although there was a method of making the part where gas leakage is expected form and detect a sensor in order to detect this slight gas leakage, it was difficult to be influenced by the temperature of external air etc. and to detect gas leakage with a sufficient precision by this approach.
[0004] Then, the technical problem of this invention is to offer the fuel supply system which can detect slight gas leakage with a sufficient precision.
[0005]
[Means for Solving the Problem] Invention according to claim 1 of this inventions which solved said technical problem In the fuel supply system which is equipped with the hydrogen tank with which it

filled up with hydrogen, and supplies hydrogen to a fuel cell through a hydrogen supply way from this hydrogen tank An amount calculation means of pressure drawdowns to compute the amount of pressure drawdowns in said hydrogen supply way from the total amount of hydrogen equivalent to the sum of the unused amount of hydrogen discharged from said fuel cell, and the amount of hydrogen consumed by generation of electrical energy of said fuel cell, It has an amount detection means of pressure drawdowns to detect the amount of pressure drawdowns in said hydrogen supply way, and beyond a predetermined value [amount / which was computed / of pressure drawdowns / said], the detected amount of pressure drawdowns is characterized by having a hydrogen leakage decision means to judge that said hydrogen has leaked, when large.

[0006] According to invention according to claim 1, the amount of pressure drawdowns in a hydrogen supply way is computed by the amount calculation means of pressure drawdowns from the unused amount of hydrogen discharged from the fuel cell, and the total amount of hydrogen equivalent to the sum of the amount of hydrogen which the fuel cell consumed. On the other hand, the actual amount of pressure drawdowns in a hydrogen supply way is detected by the amount detection means of pressure drawdowns. And it is judged that hydrogen has leaked beyond the predetermined value with the hydrogen leakage decision means rather than the amount of pressure drawdowns which the actual amount of pressure drawdowns detected with the amount detection means of pressure drawdowns computed with the amount calculation means of pressure drawdowns when large. When it is judged that hydrogen has leaked with this hydrogen leakage decision means, while hydrogen leakage is reported by for example, the information means, supply of the hydrogen from a hydrogen tank is made to intercept by closing a latching valve.

[0007] Invention according to claim 2 is characterized by said unused amount of hydrogen being the amount of wear hydrogen and/or the amount of purge hydrogen purged within said fuel cell in the configuration of invention according to claim 1.

[0008] According to invention according to claim 2, in addition to the operation by invention according to claim 1, the amount of wear hydrogen in a fuel cell is computed from the temperature and the pressure of an inlet port of a fuel cell, and the amount of purge hydrogen is computed from opening, time amount, etc. of a purge valve.

[0009] Invention according to claim 3 is characterized by having an amendment means to amend said total amount of hydrogen according to the condition of the hydrogen in said hydrogen supply way in the configuration of invention according to claim 1 or 2.

[0010] According to invention according to claim 3, in addition to the operation by invention according to claim 1 or 2, the total amount of hydrogen is amended according to the pressure and temperature of hydrogen in a hydrogen supply way.

[0011] In the fuel supply system which invention according to claim 4 is equipped with the fuel tank where it filled up with fuel gas, and supplies fuel gas to a gas engine through a fuel gas supply way from this fuel tank An amount detection means of pressure drawdowns to detect the amount of pressure drawdowns in said fuel gas supply way, An amendment means to amend the fuel gas consumption which said gas engine consumed according to the condition of said fuel gas, An amount calculation means of pressure drawdowns to compute the amount of pressure drawdowns in said fuel gas supply way from this amended fuel gas consumption, Beyond a predetermined value [amount / which was computed / of pressure drawdowns / said], a preparation and said detected amount of pressure drawdowns are characterized by having a gas leakage decision means to judge that said fuel gas has leaked, when large.

[0012] According to invention according to claim 4, the fuel gas consumption which the gas engine consumed is amended by the amendment means according to the condition of fuel gas. The amount of pressure drawdowns in a fuel gas supply way is computed by the amount calculation means of pressure drawdowns from this amended fuel gas consumption. On the other hand, the actual amount of pressure drawdowns in a fuel gas supply way is detected by the amount detection means of pressure drawdowns. And it is judged that fuel gas has leaked beyond the predetermined value with the gas leakage decision means rather than the amount of pressure drawdowns which the actual amount of pressure drawdowns

detected with the amount detection means of pressure drawdowns computed with the amount calculation means of pressure drawdowns when large. When it is judged that fuel gas has leaked with this gas leakage decision means, while gas leakage is reported by for example, the information means, supply of the fuel gas from a fuel tank is made to intercept by closing a latching valve.
[0013] Invention according to claim 5 is characterized by amending said amendment means according to the pressure and/or temperature of said fuel gas in the configuration of invention according to claim 4.
[0014] According to invention according to claim 5, in addition to the operation by invention according to claim 4, the fuel gas consumption which the gas engine consumed is amended by the amendment means according to the pressure and temperature of fuel gas.
[0015]
[Embodiment of the Invention] Hereafter, with reference to a drawing, the detail of the fuel supply system concerning this invention is explained. This operation gestalt applies this invention to the fuel supply system which supplies hydrogen to a fuel cell.
[0016] As shown in drawing 1 , the fuel supply system 1 is mainly equipped with the hydrogen supply way 12 connected to the hydrogen tank 11 with which it filled up with the hydrogen (fuel gas) which is a fuel, and this hydrogen tank 11. In this fuel supply system 1, the hydrogen in a hydrogen tank 11 is supplied to the fuel cell (gas engine) 2 through the hydrogen supply way 12.
[0017] In tank valve 11a is prepared in a hydrogen tank 11, and cutoff of supply of hydrogen or its supply is performed by closing motion of this in tank valve 11a. The 1st regulator 12b, latching valve 12a, the 2nd regulator 12c, and ejector 12d are prepared in the hydrogen supply way 12 sequentially from the hydrogen tank 11 side in the proper place, respectively. Circuit 12e for reusing the unused hydrogen which did not contribute to a generation of electrical energy in the fuel cell 2 is connected to this ejector 12d. 12f of purge valves which open by the purge command from a monitor means which is not illustrated to supervise the operational status of a fuel cell 2 is prepared in this circuit 12e. In addition, it opens, when it is prepared in order to refresh the condition by the side of the hydrogen pole of a fuel cell 2, for example, the generation water by generation of electrical energy of a fuel cell 2 collects in circuit 12e, and 12f of this purge valve discharges generation water with the hydrogen in circuit 12e.
[0018] And between in tank valve 11a in the hydrogen supply way 12, and 1st regulator 12b, the 1st sensor (the amount detection means of pressure drawdowns) 3 which always detects the pressure (the amount of pressure drawdowns) P1 and temperature T1 of hydrogen of the interior is formed. Moreover, between ejector 12d in this hydrogen supply way 12, and a fuel cell 2, the 2nd sensor 4 which always detects the pressure P2 and temperature T2 of that interior is formed. Furthermore, the 3rd sensor 5 which detects the released time is formed in 12f of purge valves of circuit 12e. The pressure which the 1st sensor 3 incidentally detects in the condition that in tank valve 11a is open is the same as the pressure inside a hydrogen tank 11.
[0019] On the other hand, the opening sensor 6 which detects the accelerator opening equivalent to the amount of treading in is formed in the accelerator pedal AP. This opening sensor 6 transmits the command value based on accelerator opening to a fuel cell 2, and is generating the current of the specified quantity from this fuel cell 2. And these opening sensor 6 and said 1-3rd sensors 3-5 are connected to ECU (control microcomputer)7. While the hydrogen leakage decision means 71 is built into that interior as a program by this ECU7, the information means 8, such as a warning buzzer and an alarm lamp, are connected to the connection terminal of that exterior. In addition, the "amount calculation means of pressure drawdowns" in this operation gestalt is constituted by the 1st - the 3rd sensor 3-5, the opening sensor 6 of an accelerator pedal AP, and ECU7.
[0020] The hydrogen leakage decision means 71 of ECU7 is constituted including amount setting means of generations of electrical energy 71a, amount setting means of consumption hydrogen 71b, amount setting means of purge hydrogen 71c, the 71d of the amount setting means of wear hydrogen, total amount calculation means of hydrogen 71e, 71f of consistency correction value setting means, the amount calculation means 71g and 71h of pressure drawdowns, and leakage judging means 71i, as shown in drawing 2 . In addition, although it shall consist of these operation gestalten as a program

which functions the hydrogen leakage decision means 71 inside ECU7, it cannot be overemphasized that it may be constituted in hardware.

[0021] Hereafter, each configuration of the hydrogen leakage decision means 71 is explained. Amount setting means of generations of electrical energy 71a inputs the command value from the opening sensor 6, and sets up the amount of generations of electrical energy of a fuel cell 2. For this reason, this amount setting means of generations of electrical energy 71a has the map which sets up the amount of generations of electrical energy from a command value.

[0022] Amount setting means of consumption hydrogen 71b inputs the amount of generations of electrical energy set up by amount setting means of generations of electrical energy 71a, and sets up the amount of consumption hydrogen consumed with the fuel cell 2. For this reason, this amount setting means of consumption hydrogen 71b has the map which sets up the amount of consumption hydrogen from the amount of generations of electrical energy.

[0023] Amount setting means of purge hydrogen 71c inputs the pressure P2 and temperature T2 which the 2nd sensor 4 detected as the valve-opening time amount which is 12f of purge valves which the 3rd sensor 5 detected, and sets up the amount of purge hydrogen purged outside. For this reason, this amount setting means of purge hydrogen 71c has the map which sets up the amount of purge hydrogen from valve-opening time amount, a pressure P2, and temperature T2. That is, with this operation gestalt, the density correction of the purged amount of hydrogen is carried out with the pressure P2 and temperature T2 in circuit 12e detected by the 2nd sensor 4. By doing so, it becomes possible to set up the amount of hydrogen more unused to accuracy, and the judgment precision of leakage judging means 71i which carries out a postscript improves.

[0024] The 71d of the amount setting means of wear hydrogen inputs the pressure P2 and temperature T2 which the 2nd sensor 4 detected, and the amount of wear hydrogen worn down in addition to said amount of consumption hydrogen and the amount of purge hydrogen is set up. For this reason, the 71d of this amount setting means of wear hydrogen has the map which sets up the amount of wear hydrogen from a pressure P2 and temperature T2. That is, with this operation gestalt, the density correction of this amount of wear hydrogen is carried out with the pressure P2 and temperature T2 in circuit 12e detected by the 2nd sensor 4. By doing so, it becomes possible to set up the amount of hydrogen more unused to accuracy, and the judgment precision of leakage judging means 71i which carries out a postscript improves.

[0025] Here, in the case where two or more cels are the fuel cells by which the laminating (stack) was carried out as an amount of wear hydrogen, the hydrogen which begins to leak from the clearance between each cel is mentioned. The amount of wear hydrogen in that case will increase, if a pressure becomes high, and it is in the inclination which will decrease if temperature becomes high. Incidentally, a fuel cell has the structure which carried out the laminating, dividing with a metal separator the membrane electrode structure (MEA) which put the electrolyte membrane on the hydrogen pole and the oxygen pole. In addition, in the time of usual operation of a fuel cell 2, the relation of the amount of supply hydrogen (the total amount of hydrogen) supplied to the amount of consumption hydrogen, the amount of purge hydrogen, the amount of wear hydrogen, and a fuel cell 2 is as follows. <amount of supply hydrogen> = <amount of consumption hydrogen> + <amount of purge hydrogen> + <amount of wear hydrogen> [0026 --] The total amount calculation means of hydrogen 71e computes the total amount of hydrogen by adding the amount of consumption hydrogen, the amount of purge hydrogen, and the amount of wear hydrogen which were set up by said amount setting means of consumption hydrogen 71b, amount setting means of purge hydrogen 71c, and the 71d of the amount setting means of wear hydrogen. For this reason, this total amount calculation means of hydrogen 71e has an adder adding the amount of consumption hydrogen, the amount of purge hydrogen, and the amount of wear hydrogen.

[0027] 71f of consistency correction value setting means inputs the temperature T1 and the pressure P1 which the 1st sensor 3 detected, and the consistency correction value for bringing said total amount of hydrogen computed as ideal gas close to the amount as real gas is set up. For this reason, 71f of this consistency correction value setting means has the map which sets up consistency correction value from

temperature T1 and a pressure P1.
[0028] The 71g of the amount calculation means of pressure drawdowns computes the amount of pressure drawdowns which shows the amount in which the pressure in the hydrogen supply way 12 descends between predetermined time based on said consistency correction value and the total amount of hydrogen. Here, the hydrogen by which this computed amount of pressure drawdowns is supplied to a fuel cell 2 expresses the amount of pressure drawdowns between in tank valve 11a when having passed along the hydrogen supply way 12, without leaking, and 1st regulator 12b (it is also called "the computed amount of pressure drawdowns" the amount of pressure drawdowns on count, and the following) from the hydrogen tank 11. On the other hand, the 71h of the amount calculation means of pressure drawdowns computes the actual amount of pressure drawdowns between in tank valve 11a and 1st regulator 12b (henceforth "the detected amount of pressure drawdowns") based on the pressure P1 which the 1st sensor 3 detected.
[0029] Leakage judging means 71i inputs said detected amount of pressure drawdowns, and the computed amount of pressure drawdowns, judges with hydrogen having leaked, if larger beyond a predetermined value than the amount of pressure drawdowns by which this detected amount of pressure drawdowns was computed (i.e., if the difference of the detected amount of pressure drawdowns and the computed amount of pressure drawdowns is beyond a predetermined value), and outputs an alarm signal. It judges with in other words, having had hydrogen leakage, when this leakage judging means 71i had few amounts of hydrogen which actually remained in the hydrogen tank 11 than the amount which subtracted the predetermined value which took the error etc. into consideration in the amount of hydrogen which remained in the hydrogen tank 11 presumed from the amount of consumption hydrogen, the amount of purge hydrogen, and the amount of wear hydrogen, as shown in drawing 3 , and an alarm signal is outputted. For this reason, this leakage judging means 71i has the function which generates the alarm signal for operating the information means 8 while having the comparative judgment function to judge hydrogen leakage for the difference of the detected amount of pressure drawdowns, and the computed amount of pressure drawdowns as compared with a predetermined value. In addition, said predetermined value for judging hydrogen leakage has a threshold for detecting leakage, or the meaning of a neutral zone. This predetermined value is defined from the experimental value and theoretical calculated value in consideration of a system volume etc. Here, if this predetermined value is made small, little hydrogen leakage is detectable, and incorrect information can be prevented if it enlarges.
[0030] Next, actuation of a fuel supply system 1 is explained. First, in tank valve 11a and latching valve 12a are made to open wide, and hydrogen is made to emit from a hydrogen tank 11, as shown in drawing 1 . The hydrogen sent from this hydrogen tank 11 is decompressed by the proper pressure with the 1st and 2 regulators 12b and 12c, and is supplied to a fuel cell 2 through ejector 12d. This fuel cell 2 supplies the current outputted by that generation of electrical energy to Motor M. And the hydrogen which was not consumed by generation of electrical energy of this fuel cell 2 is returned to ejector 12d through circuit 12e. 12f of purge valves prepared in this circuit 12e is wide opened by the purge command from a monitor means, and they make hydrogen purge to the exterior, and if the pressure in circuit 12e serves as a predetermined value, they will be closed. Thus, while hydrogen is supplied to the fuel cell 2 from the hydrogen tank 11, the detection value detected by the 1-3rd sensors 3-5 and opening sensors 6 is always sent to ECU7.
[0031] In ECU7, as shown in drawing 2 , based on the command value transmitted from the opening sensor 6, amount setting means of generations of electrical energy 71a sets up the amount of generations of electrical energy of a fuel cell, and amount setting means of consumption hydrogen 71b sets up the amount of consumption hydrogen based on this amount of generations of electrical energy. Based on the pressure P2 and temperature T2 which are transmitted from the released time of 12f of purge valves transmitted from the 3rd sensor 5, and the 2nd sensor 4, amount setting means of purge hydrogen 71c sets up the amount of purge hydrogen. Based on the pressure P2 and temperature T2 which are transmitted from the 2nd sensor 4, the 71d of the amount setting means of wear hydrogen sets up the amount of wear hydrogen. And said amount of consumption hydrogen, and the amount of purge

hydrogen and the amount of wear hydrogen which were discharged from the fuel cell and which are the unused amount of hydrogen are added by the total amount calculation means of hydrogen 71e, and the total amount of hydrogen is computed.

[0032] Based on the pressure P1 and temperature T1 which are transmitted from the 1st sensor 3, 71f of consistency correction value setting means sets up consistency correction value according to the condition of hydrogen. This consistency correction value turns into a value which amends said total amount of hydrogen greatly, so that the pressure P1 detected by the 1st sensor 3 is high, and it turns into a value which amends said total amount of hydrogen small, so that that temperature T1 is low. And based on this consistency correction value and said total amount of hydrogen, the 71g of the amount calculation means of pressure drawdowns computes the amount of pressure drawdowns. On the other hand, based on the pressure P1 transmitted from the 1st sensor 3, the 71h of the amount calculation means of pressure drawdowns computes the actual amount of pressure drawdowns.

[0033] Thus, the amount of pressure drawdowns computed by the 71g of the amount calculation means of pressure drawdowns and the actual amount of pressure drawdowns (the detected amount of pressure drawdowns) computed by the 71h of the amount calculation means of pressure drawdowns are measured by leakage judging means 71i. And if the difference of the detected amount of pressure drawdowns and the computed amount of pressure drawdowns is beyond a predetermined value, leakage judging means 71i will judge with hydrogen having leaked.

[0034] Thus, when it is judged that hydrogen has leaked with the hydrogen leakage decision means 71 (leakage judging means 71i) of ECU7, as shown in drawing 1 , it is reported that that signal was sent to the information means 8, and hydrogen has leaked with this information means 8. Furthermore, the hydrogen cutoff signal which makes in tank valve 11a and latching valve 12a intercept supply of hydrogen by ECU7 is sent, and these valves 11a and 12a are closed.

[0035] According to the above, the following effectiveness can be acquired in this operation gestalt. Since the detected amount of pressure drawdowns which shows the amount of pressure drawdowns showing a value when the computed amount of pressure drawdowns, i.e., hydrogen, has passed along the hydrogen supply way 12, without leaking, and an actual value is measured, when the difference of the detected amount of pressure drawdowns and the computed amount of pressure drawdowns is beyond a predetermined value, it can be judged that hydrogen has leaked. Moreover, since it is not necessary to set up more highly the set point for closing a valve like before by measuring the amount of pressure drawdowns computed from the total amount of hydrogen of a fuel cell 2 in this way, and the actual amount of pressure drawdowns from the amount of pressure drawdowns corresponding to the maximum consumption of a fuel cell etc., few hydrogen leakage is detectable with a sufficient precision.

[0036] As mentioned above, this invention is carried out with various gestalten, without being limited to said operation gestalt. Although it considered as the structure of using the command value by the opening sensor 6, with this operation gestalt in order to set up the amount of consumption hydrogen of a fuel cell 2, this invention is not limited to this. For example, a sensor detects the current value and electrical-potential-difference value which are taken out from a fuel cell, and you may make it compute the amount of consumption hydrogen of a fuel cell based on this detection value. Although the amount of purge hydrogen was computed with this operation gestalt based on the released time of 12f of purge valves detected by the 3rd sensor 5, this invention is not ** limited to this. For example, the amount of purge hydrogen may be computed based on the purge command value of opening a predetermined time purge valve, at the time of a purge command, and direct detection of the amount of hydrogen discharged from a purge valve may be carried out, and you may compute based on the detection value. Although the total amount of hydrogen is computed with this operation gestalt using the amount of purge hydrogen and the amount of wear hydrogen which are discharged from a fuel cell, this invention may compute the total amount of hydrogen using the amount of unused hydrogen of which or one of the two, when it is not limited to this, for example, one of purge hydrogen and wear hydrogen can ignore in a minute amount.

[0037]

[Effect of the Invention] According to invention according to claim 1, by measuring the detected amount

of pressure drawdowns which shows the computed amount of pressure drawdowns, and an actual value, since it is not necessary to set up more highly the set point for closing a valve like before rather than the flow rate or the amount of pressure drawdowns corresponding to the maximum consumption of a fuel cell, few hydrogen leakage is detectable with a sufficient precision.

[0038] Since the unused amount of hydrogen is computed [according to invention according to claim 2] by dividing it into the amount of wear hydrogen and the amount of purge hydrogen in a fuel cell in addition to the effectiveness by invention according to claim 1, few hydrogen leakage can be detected with a more sufficient precision.

[0039] According to invention according to claim 3, since the total amount of hydrogen is amended according to the pressure and temperature of hydrogen in a hydrogen supply way in addition to the effectiveness by invention according to claim 1 or 2, few hydrogen leakage can be detected with a more sufficient precision.

[0040] According to invention according to claim 4, by measuring the detected amount of pressure drawdowns which shows the computed amount of pressure drawdowns, and an actual value, since it is not necessary to make the set point for closing a valve like before into height, slight gas leakage is detectable with a sufficient precision.

[0041] According to invention according to claim 5, slight gas leakage is detectable with a sufficient precision like the effectiveness by invention according to claim 4.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the configuration of the fuel supply system concerning this operation gestalt.
[Drawing 2] It is the block diagram showing the hydrogen leakage decision means concerning this operation gestalt.
[Drawing 3] It is the conceptual diagram showing the concept of the judgment approach of the leakage judging means concerning this operation gestalt.
[Description of Notations]
1 Fuel Supply System
11 Hydrogen Tank
12 Hydrogen Supply Way
2 Fuel Cell
3 1st Sensor (the Amount Detection Means of Pressure Drawdowns)
4 2nd Sensor
5 3rd Sensor
6 Opening Sensor
7 ECU
71 Hydrogen Leakage Decision Means

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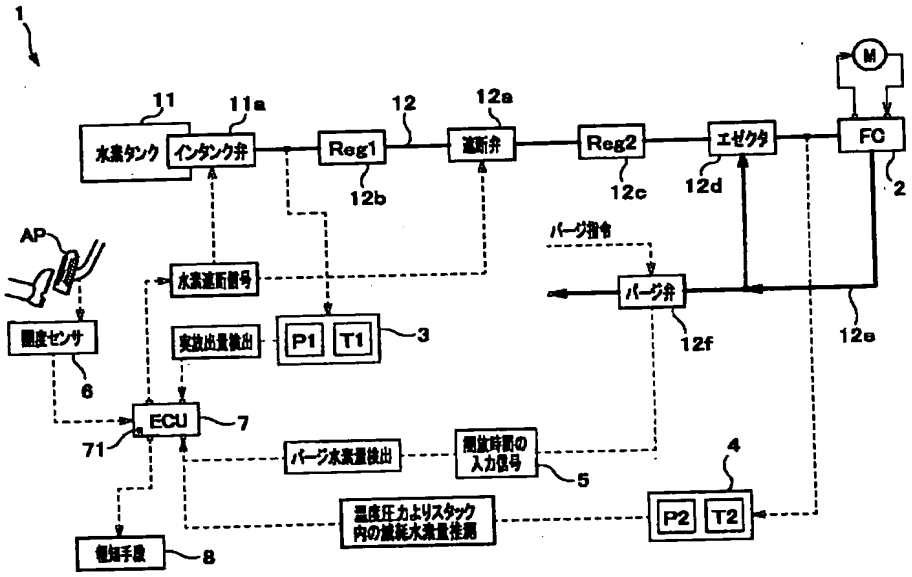
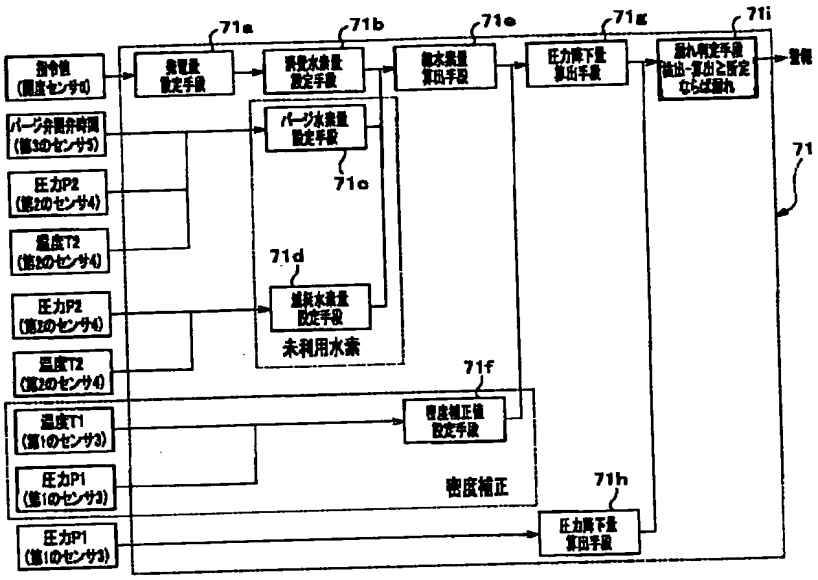
DRAWINGS

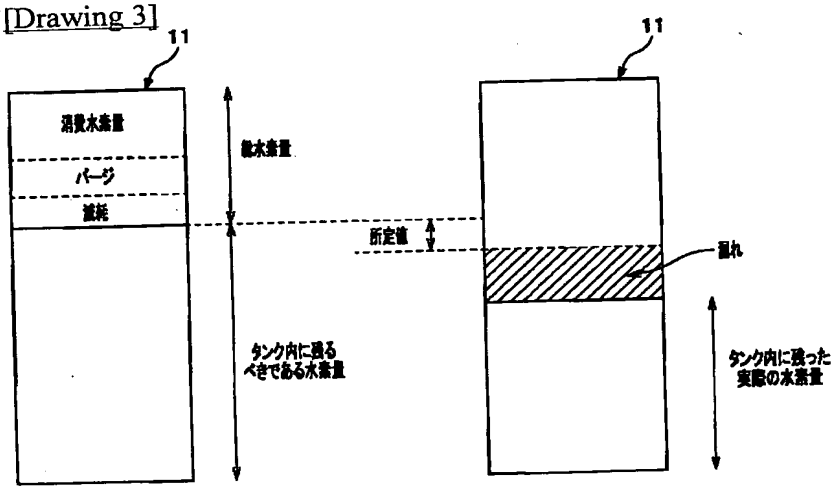
[Drawing 1]



[Drawing 2]



[Drawing 3]



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CORRECTION OR AMENDMENT

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F02M 21/02

[FI]

F02M 21/02 V
F02M 21/02 G

[Procedure revision]
[Filing Date] August 25, Heisei 16 (2004. 8.25)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[The contents of amendment]
[Claim(s)]
[Claim 1]
It has the hydrogen tank with which it filled up with hydrogen,
In the fuel supply system which supplies hydrogen to a fuel cell through a hydrogen supply way from this hydrogen tank,
An amount calculation means of pressure drawdowns to compute the amount of pressure drawdowns in said hydrogen supply way from the total amount of hydrogen equivalent to the sum of the unused amount of hydrogen discharged from said fuel cell, and the amount of hydrogen consumed by generation of electrical energy of said fuel cell,
It has an amount detection means of pressure drawdowns to detect the amount of pressure drawdowns in said hydrogen supply way,
It is the fuel supply system characterized by equipping the detected amount of pressure drawdowns with a hydrogen leakage decision means to judge that said hydrogen has leaked beyond the predetermined value rather than said computed amount of pressure drawdowns when large.
[Claim 2]
Said unused amount of hydrogen is a fuel supply system according to claim 1 characterized by being the

amount of wear hydrogen and/or the amount of purge hydrogen purged within said fuel cell.
[Claim 3]
The fuel supply system according to claim 1 or 2 characterized by having an amendment means to amend said total amount of hydrogen according to the condition of the hydrogen in said hydrogen supply way.
[Claim 4]
It has the fuel tank where it filled up with fuel gas,
In the fuel supply system which supplies fuel gas to a gas engine through a fuel gas supply way from this fuel tank,
An amount detection means of pressure drawdowns to detect the amount of pressure drawdowns in said fuel gas supply way,
An amendment means to amend the fuel gas consumption which said gas engine consumed according to the condition of said fuel gas,
It has an amount calculation means of pressure drawdowns to compute the amount of pressure drawdowns in said fuel gas supply way from this amended fuel gas consumption,
It is the fuel supply system characterized by equipping said detected amount of pressure drawdowns with a gas leakage decision means to judge that said fuel gas has leaked beyond the predetermined value rather than said computed amount of pressure drawdowns when large.
[Claim 5]
Said amendment means is a fuel supply system according to claim 4 characterized by amending according to the pressure and/or temperature of said fuel gas.
[Claim 6]
It has the hydrogen tank with which it filled up with hydrogen,
In the fuel supply system which supplies hydrogen to a fuel cell through a hydrogen supply way from this hydrogen tank,
A pressure calculation means to compute the pressure in said hydrogen tank from the total amount of hydrogen equivalent to the sum of the unused amount of hydrogen discharged from said fuel cell, and the amount of hydrogen consumed by generation of electrical energy of said fuel cell,
It has a pressure detection means to detect the pressure in said hydrogen tank,
It is the fuel supply system characterized by having a hydrogen leakage decision means to judge that said hydrogen has leaked when said detected pressure is smaller than the value which subtracted the predetermined value from said computed pressure.
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0014
[Method of Amendment] Modification
[The contents of amendment]
[0014]
According to invention according to claim 5, in addition to the operation by invention according to claim 4, the fuel gas consumption which the gas engine consumed is amended by the amendment means according to the pressure and temperature of fuel gas.
Moreover, invention according to claim 6 is equipped with the hydrogen tank with which it filled up with hydrogen, and sets it to the fuel supply system which supplies hydrogen to a fuel cell through a hydrogen supply way from this hydrogen tank. A pressure calculation means to compute the pressure in said hydrogen tank from the total amount of hydrogen equivalent to the sum of the unused amount of hydrogen discharged from said fuel cell, and the amount of hydrogen consumed by generation of electrical energy of said fuel cell, It is characterized by having had a pressure detection means to detect the pressure in said hydrogen tank, and having a hydrogen leakage decision means to judge that said hydrogen has leaked when said detected pressure is smaller than the value which subtracted the predetermined value from said computed pressure.

[Translation done.]

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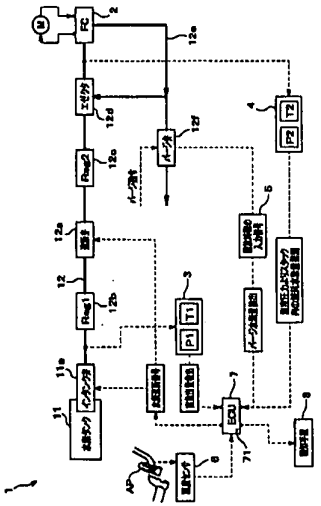
(54)【発明の名称】燃料供給装置

(57)【要約】
【課題】　本発明では、わずかなガス漏れを精度良く検知することができる燃料供給装置を提供することを課題とする。
【解決手段】　燃料供給装置1は、第1～第3のセンサ3～5、開度センサ6およびECU7により燃料電池2から排出された未利用の水素量と、燃料電池2の消費した消費水素量の和に相当する総水素量から水素供給路12内の圧力降下量を算出する。第1のセンサ3により、水素供給路12内の圧力降下量を検出する。そして、検出された圧力降下量が算出された圧力降下量よりも所定値以上であるときは、ECU7により水素が漏れていると判断する。



【特許請求の範囲】
【請求項1】　水素が充填された水素タンクを備え、この水素タンクから水素を水素供給路を介して燃料電池に供給する燃料供給装置において、
前記燃料電池から排出された未利用の水素量と、前記燃料電池の発電により消費した水素量の和に相当する総水素量から前記水素供給路内の圧力降下量を算出する圧力降下量算出手段と、
前記水素供給路内の圧力降下量を検出する圧力降下量検出手段を備え、
検出された圧力降下量が前記算出された圧力降下量よりも所定値以上大きいときは前記水素が漏れていると判断する水素漏れ判断手段を備えたことを特徴とする燃料供給装置。
【請求項2】　前記未利用の水素量は前記燃料電池内での減耗水素量および／またはパージされるパージ水素量であることを特徴とする請求項1に記載の燃料供給装置。
【請求項3】　前記総水素量を前記水素供給路内の水素の状態に応じて補正する補正手段を備えたことを特徴とする請求項1または請求項2に記載の燃料供給装置。
【請求項4】　燃料ガスが充填された燃料タンクを備え、
この燃料タンクから燃料ガスを燃料ガス供給路を介してガス機関に供給する燃料供給装置において、
前記燃料ガス供給路内の圧力降下量を検出する圧力降下量検出手段と、
前記ガス機関が消費した燃料ガス消費量を前記燃料ガスの状態に応じて補正する補正手段と、
この補正された燃料ガス消費量から前記燃料ガス供給路内の圧力降下量を算出する圧力降下量算出手段と、を備え、
前記検出された圧力降下量が前記算出された圧力降下量よりも所定値以上大きいときは前記燃料ガスが漏れていると判断するガス漏れ判断手段を備えたことを特徴とする燃料供給装置。
【請求項5】　前記補正手段は前記燃料ガスの圧力および／または温度に応じて補正することを特徴とする請求項4に記載の燃料供給装置。
【発明の詳細な説明】
【0001】
【発明の属する技術分野】本発明は、燃料ガスを供給する燃料供給装置に関し、特に、燃料ガスの漏れを検知する手段を備えた燃料供給装置に関するものである。
【0002】
【従来の技術】従来、水素や圧縮天然ガス等の燃料ガスにより駆動する車両は、この燃料ガスを貯留しておくタンクや、このタンクから燃料電池やエンジン等に燃料ガスを供給するための燃料供給管で主に構成される燃料供給装置を備えている。そして、このような燃料供給装置には、ガス漏れ対策として、ガスが漏れたときに燃料供給管を遮断する過流防止弁が設けられている。具体的に、この過流防止弁は、ガスが漏れたことにしたがい燃料供給管内を流れるガス流量が増加することを利用し、過剰な流量が流れたときに燃料供給管を塞ぐ遮断機構を備えた構造になっている。また別なガス漏れ対策として、燃料供給管を流れる燃料ガスの圧力を検出する圧力センサと、この圧力センサの検出値に基づいて燃料ガスの供給を遮断する遮断弁を備えた燃料供給装置がある。具体的に、この燃料供給装置は、燃料供給管を流れる燃料ガスの圧力が圧力センサにより常時検出され、この検出値から算出した圧力降下量が所定の圧力降下量以上になれば、遮断弁が閉じられる構造になっている。
【0003】
【発明が解決しようとする課題】しかしながら、従来のような過流防止弁を備えた構造では、通常の運転時に過流防止弁が作動しないように、過流防止弁を閉じるための設定流量を燃料電池等のガス機関の最大消費よりも高めに設定していたので、わずかなガス漏れを検知することが困難であり、遮断機構が作動しないことがあった。また、燃料供給管を流れる燃料ガスの圧力を検出する圧力センサと、この圧力センサの検出値に基づいて燃料ガスの供給を遮断する遮断弁を設けた構造では、通常の運転時に遮断弁が作動しないように、遮断弁を閉じるための設定圧力降下量を燃料電池等の最大消費量に対応する圧力降下量よりも高めに設定していたので、わずかなガス漏れを検知することが困難であった。また、このわずかなガス漏れを検知するために、ガス漏れの予想される個所にセンサを設けて検知させる方法があるが、この方法では、外部の空気の温度等に影響されてガス漏れを精度良く検知することが困難であった。
【0004】そこで、本発明の課題は、わずかなガス漏れを精度良く検知することができる燃料供給装置を提供することにある。
【0005】
【課題を解決するための手段】前記課題を解決した本発明のうちの請求項1に記載の発明は、水素が充填された水素タンクを備え、この水素タンクから水素を水素供給路を介して燃料電池に供給する燃料供給装置において、
前記燃料電池から排出された未利用の水素量と、前記燃料電池の発電により消費した水素量の和に相当する総水素量から前記水素供給路内の圧力降下量を算出する圧力降下量算出手段と、前記水素供給路内の圧力降下量を検出する圧力降下量検出手段を備え、検出された圧力降下量が前記算出された圧力降下量よりも所定値以上大きいときは前記水素が漏れていると判断する水素漏れ判断手段を備えたことを特徴とする。
【0006】請求項1に記載の発明によれば、圧力降下量算出手段により、燃料電池から排出された未利用の水素量と燃料電池の消費した水素量の和に相当する総水素

量から水素供給路内の圧力降下量が算出される。一方、圧力降下量検出手段により、水素供給路内の実際の圧力降下量が検出される。そして、水素漏れ判断手段により、圧力降下量検出手段で検出した実際の圧力降下量が、圧力降下量算出手段で算出した圧力降下量よりも所定値以上大きいときは、水素が漏れていると判断される。この水素漏れ判断手段により水素が漏れていると判断された場合には、たとえば、報知手段により水素漏れが報知されるとともに、遮断弁を閉じることにより水素タンクからの水素の供給を遮断させる。

【０００７】請求項２に記載の発明は、請求項１に記載の発明の構成において、前記未利用の水素量は前記燃料電池内での減耗水素量および／またはパージされるパージ水素量であることを特徴とする。

【０００８】請求項２に記載の発明によれば、請求項１に記載の発明による作用に加え、たとえば、燃料電池内の減耗水素量が燃料電池の入口の温度や圧力から算出され、パージ水素量がパージ弁の開度や時間等から算出される。

【０００９】請求項３に記載の発明は、請求項１または請求項２に記載の発明の構成において、前記総水素量を前記水素供給路内の水素の状態に応じて補正する補正手段を備えたことを特徴とする。

【００１０】請求項３に記載の発明によれば、請求項１または請求項２に記載の発明による作用に加え、たとえば、総水素量が水素供給路内の水素の圧力と温度に応じて補正される。

【００１１】請求項４に記載の発明は、燃料ガスが充填された燃料タンクを備え、この燃料タンクから燃料ガスを燃料ガス供給路を介してガス機関に供給する燃料供給装置において、前記燃料ガス供給路内の圧力降下量を検出する圧力降下量検出手段と、前記ガス機関が消費した燃料ガス消費量を前記燃料ガスの状態に応じて補正する補正手段と、この補正された燃料ガス消費量から前記燃料ガス供給路内の圧力降下量を算出する圧力降下量算出手段と、を備え、前記検出された圧力降下量が前記算出された圧力降下量よりも所定値以上大きいときは前記燃料ガスが漏れていると判断するガス漏れ判断手段を備えたことを特徴とする。

【００１２】請求項４に記載の発明によれば、補正手段により、ガス機関が消費した燃料ガス消費量が燃料ガスの状態に応じて補正される。この補正された燃料ガス消費量から燃料ガス供給路内の圧力降下量が圧力降下量算出手段により算出される。一方、圧力降下量検出手段により、燃料ガス供給路内の実際の圧力降下量が検出される。そして、ガス漏れ判断手段により、圧力降下量検出手段で検出した実際の圧力降下量が、圧力降下量算出手段で算出した圧力降下量よりも所定値以上大きいときは、燃料ガスが漏れていると判断される。このガス漏れ判断手段により燃料ガスが漏れていると判断された場合

には、たとえば、報知手段によりガス漏れが報知されるとともに、遮断弁を閉じることにより燃料タンクからの燃料ガスの供給を遮断させる。

【００１３】請求項５に記載の発明は、請求項４に記載の発明の構成において、前記補正手段は前記燃料ガスの圧力および／または温度に応じて補正することを特徴とする。

【００１４】請求項５に記載の発明によれば、請求項４に記載の発明による作用に加え、たとえば、補正手段により、ガス機関が消費した燃料ガス消費量が燃料ガスの圧力と温度に応じて補正される。

【００１５】

【発明の実施の形態】以下、図面を参照して、本発明に係る燃料供給装置の詳細について説明する。この実施形態は、水素を燃料電池に供給する燃料供給装置に本発明を適用したものである。

【００１６】図１に示すように、燃料供給装置１は、燃料である水素（燃料ガス）が充填された水素タンク１１と、この水素タンク１１に接続される水素供給路１２を主に備えている。この燃料供給装置１では、水素タンク１１内の水素を水素供給路１２を介して燃料電池（ガス機関）２に供給している。

【００１７】水素タンク１１にはインタンク弁１１ａが設けられ、このインタンク弁１１ａの開閉により水素の供給やその供給の遮断が行われている。水素供給路１２には、水素タンク１１側から順に、第１のレギュレータ１２ｂ、遮断弁１２ａ、第２のレギュレータ１２ｃおよびエゼクタ１２ｄがそれぞれ適所に設けられている。このエゼクタ１２ｄには、燃料電池２内において発電に寄与しなかった未利用の水素を再利用するための循環路１２ｅが接続されている。この循環路１２ｅには、燃料電池２の運転状態を監視する図示しない監視手段からのパージ指令により開弁するパージ弁１２ｆが設けられている。なお、このパージ弁１２ｆは、燃料電池２の水素極側の状態をリフレッシュする目的で設けられており、たとえば、循環路１２ｅ内に燃料電池２の発電による生成水が溜まった場合などに開弁され、循環路１２ｅ内の水素とともに生成水を排出する。

【００１８】そして、水素供給路１２におけるインタンク弁１１ａと第１のレギュレータ１２ｂの間には、その内部の水素の圧力（圧力降下量）Ｐ１および温度Ｔ１を常時検出する第１のセンサ（圧力降下量検出手段）３が設けられている。また、この水素供給路１２におけるエゼクタ１２ｄと燃料電池２の間には、その内部の圧力Ｐ２および温度Ｔ２を常時検出する第２のセンサ４が設けられている。さらに、循環路１２ｅのパージ弁１２ｆには、その開放時間を検出する第３のセンサ５が設けられている。ちなみに、インタンク弁１１ａが開いている状態では、第１のセンサ３が検出する圧力は、水素タンク１１の内部の圧力と同じである。

【００１９】一方、アクセルペダルＡＰには、その踏み込み量に相当するアクセル開度を検出する開度センサ６が設けられている。この開度センサ６は、アクセル開度に基づく指令値を燃料電池２に送信して、この燃料電池２から所定量の電流を発生させている。そして、この開度センサ６および前記第１～３のセンサ３～５はＥＣＵ（制御マイコン）７に接続されている。このＥＣＵ７には、その内部に水素漏れ判断手段７１がプログラムとして組み込まれているとともに、その外部の接続端子に警報ブザーや警報ランプ等の報知手段８が接続されている。なお、本実施形態における「圧力降下量算出手段」は、第１～第３のセンサ３～５、アクセルペダルＡＰの開度センサ６およびＥＣＵ７によって構成されている。

【００２０】ＥＣＵ７の水素漏れ判断手段７１は、図２に示すように、発電量設定手段７１ａ、消費水素量設定手段７１ｂ、パージ水素量設定手段７１ｃ、減耗水素量設定手段７１ｄ、総水素量算出手段７１ｅ、密度補正値設定手段７１ｆ、圧力降下量算出手段７１ｇ，７１ｈ、漏れ判定手段７１ｉを含んで構成される。なお、本実施形態では、水素漏れ判断手段７１をＥＣＵ７の内部で機能するプログラムとして構成されるものとしたが、ハードウェア的に構成されていてもよいのはいうまでもない。

【００２１】以下、水素漏れ判断手段７１の各構成を説明する。発電量設定手段７１ａは、開度センサ６からの指令値を入力して、燃料電池２の発電量を設定する。このため、この発電量設定手段７１ａは、指令値から発電量を設定するマップを有する。

【００２２】消費水素量設定手段７１ｂは、発電量設定手段７１ａで設定した発電量を入力して、燃料電池２により消費した消費水素量を設定する。このため、この消費水素量設定手段７１ｂは、発電量から消費水素量を設定するマップを有する。

【００２３】パージ水素量設定手段７１ｃは、第３のセンサ５が検出したパージ弁１２ｆの開弁時間と、第２のセンサ４が検出した圧力Ｐ２および温度Ｔ２を入力して、外部にパージされたパージ水素量を設定する。このため、このパージ水素量設定手段７１ｃは、開弁時間、圧力Ｐ２および温度Ｔ２からパージ水素量を設定するマップを有する。つまり、本実施形態では、パージされた水素量を、第２のセンサ４で検出された循環路１２ｅ内の圧力Ｐ２および温度Ｔ２によって密度補正している。そうすることによってより正確に未利用の水素量を設定することが可能になり、後記する漏れ判定手段７１ｉの判定精度が向上する。

【００２４】減耗水素量設定手段７１ｄは、第２のセンサ４が検出した圧力Ｐ２と温度Ｔ２を入力して、前記消費水素量およびパージ水素量以外に減耗した減耗水素量を設定する。このため、この減耗水素量設定手段７１ｄは、圧力Ｐ２と温度Ｔ２から減耗水素量を設定するマップを有する。つまり、本実施形態では、この減耗水素量を、第２のセンサ４で検出された循環路１２ｅ内の圧力Ｐ２および温度Ｔ２によって密度補正している。そうすることによってより正確に未利用の水素量を設定することが可能になり、後記する漏れ判定手段７１ｉの判定精度が向上する。

【００２５】ここで、減耗水素量としては、複数のセルが積層（スタック）された燃料電池の場合では各セルの隙間から漏れ出す水素などが挙げられる。その場合の減耗水素量は、圧力が高くなると増え、温度が高くなると減る傾向にある。ちなみに、燃料電池は、電解質膜を水素極と酸素極とで挟み込んだ膜電極構造体（ＭＥＡ）を、金属製のセパレータで仕切りながら積層した構造を有する。なお、燃料電池２の通常運転時では、消費水素量、パージ水素量、減耗水素量および燃料電池２へ供給される供給水素量（総水素量）の関係は、次の通りである。＜供給水素量＞＝＜消費水素量＞＋＜パージ水素量＞＋＜減耗水素量＞

【００２６】総水素量算出手段７１ｅは、前記消費水素量設定手段７１ｂ、パージ水素量設定手段７１ｃおよび減耗水素量設定手段７１ｄで設定された消費水素量、パージ水素量および減耗水素量を加算して総水素量を算出する。このため、この総水素量算出手段７１ｅは、消費水素量、パージ水素量および減耗水素量を加算する加算機能を有する。

【００２７】密度補正値設定手段７１ｆは、第１のセンサ３が検出した温度Ｔ１と圧力Ｐ１を入力して、理想気体として算出された前記総水素量を実在気体としての量に近づけるための密度補正値を設定する。このため、この密度補正値設定手段７１ｆは、温度Ｔ１と圧力Ｐ１から密度補正値を設定するマップを有する。

【００２８】圧力降下量算出手段７１ｇは、前記密度補正値と総水素量に基づいて、水素供給路１２内の圧力が所定時間の間に降下する量を示す圧力降下量を算出する。ここで、この算出された圧力降下量は、燃料電池２に供給される水素が水素タンク１１から水素供給路１２を漏れずに通ってきたときのインタンク弁１１ａと第１のレギュレータ１２ｂの間の圧力降下量（計算上の圧力降下量、以下、「算出された圧力降下量」ともいう）を表わしている。これに対して、圧力降下量算出手段７１ｈは、第１のセンサ３が検出した圧力Ｐ１に基づいて、インタンク弁１１ａと第１のレギュレータ１２ｂの間の実際の圧力降下量（以下、「検出された圧力降下量」ともいう）を算出する。

【００２９】漏れ判定手段７１ｉは、前記検出された圧力降下量と算出された圧力降下量を入力して、この検出された圧力降下量が算出された圧力降下量よりも所定値以上大きければ、すなわち、検出された圧力降下量と算出された圧力降下量の差が所定値以上であれば水素が漏れていると判定して、警報信号を出力する。言い換える

と、この漏れ判定手段７１ｉは、図３に示すように、消費水素量、パージ水素量および減耗水素量から推定される水素タンク１１内に残った水素量に誤差等を考慮した所定値を減算した量よりも、実際に水素タンク１１内に残った水素量が少なければ、水素漏れがあったと判定して、警報信号を出力する。このため、この漏れ判定手段７１ｉは、検出された圧力降下量と算出された圧力降下量の差を所定値と比較して水素漏れを判断する比較判断機能を有するとともに、報知手段８を作動するための警報信号を生成する機能を有する。なお、水素漏れを判断するための前記所定値は、漏れを検出するための閾値、あるいは不感帯の意義を有する。この所定値は、システムボリューム等を考慮した実験値や理論計算値から定められる。ここで、この所定値を小さくすれば少量の水素漏れを検出することができ、大きくすれば誤報知を防止することができる。

【００３０】次に、燃料供給装置１の動作について説明する。まず、図１に示すように、インタンク弁１１ａと遮断弁１２ａを開放させて、水素タンク１１から水素を放出させる。この水素タンク１１から送られる水素は、第１，２のレギュレータ１２ｂ，１２ｃにより適正な圧力に減圧され、エゼクタ１２ｄを介して燃料電池２に供給される。この燃料電池２は、その発電により出力される電流を電動機Ｍに供給する。そして、この燃料電池２の発電で消費されなかった水素は、循環路１２ｅを通ってエゼクタ１２ｄに戻される。この循環路１２ｅに設けられたパージ弁１２ｆは、監視手段からのパージ指令により開放されて水素を外部へパージさせ、循環路１２ｅ内の圧力が所定値となったら閉鎖される。このように、水素タンク１１から燃料電池２へ水素が供給されている間、第１～３のセンサ３～５および開度センサ６で検出された検出値がＥＣＵ７に常時送られている。

【００３１】ＥＣＵ７では、図２に示すように、開度センサ６から送信される指令値に基づいて発電量設定手段７１ａが燃料電池の発電量を設定し、この発電量に基づいて消費水素量設定手段７１ｂが消費水素量を設定する。第３のセンサ５から送信されるパージ弁１２ｆの開放時間と第２のセンサ４から送信される圧力Ｐ２および温度Ｔ２に基づいてパージ水素量設定手段７１ｃがパージ水素量を設定する。第２のセンサ４から送信される圧力Ｐ２および温度Ｔ２に基づいて減耗水素量設定手段７１ｄが減耗水素量を設定する。そして、前記消費水素量と、燃料電池から排出された未利用の水素量であるパージ水素量および減耗水素量とが総水素量算出手段７１ｅにより加算され、総水素量が算出される。

【００３２】第１のセンサ３から送信される圧力Ｐ１および温度Ｔ１に基づいて、すなわち水素の状態に応じて、密度補正値設定手段７１ｆが密度補正値を設定する。この密度補正値は、第１のセンサ３で検出された圧力Ｐ１が高いほど前記総水素量を大きく補正する値になり、その温度Ｔ１が低いほど前記総水素量を小さく補正する値になる。そして、この密度補正値と前記総水素量とに基づいて、圧力降下量算出手段７１ｇが圧力降下量を算出する。一方、第１のセンサ３から送信される圧力Ｐ１に基づいて、圧力降下量算出手段７１ｈが実際の圧力降下量を算出する。

【００３３】このように、圧力降下量算出手段７１ｇにより算出された圧力降下量と圧力降下量算出手段７１ｈにより算出された実際の圧力降下量（検出された圧力降下量）は、漏れ判定手段７１ｉにより比較される。そして、検出された圧力降下量と算出された圧力降下量との差が所定値以上であれば、漏れ判定手段７１ｉは水素が漏れていると判定する。

【００３４】このように、ＥＣＵ７の水素漏れ判断手段７１（漏れ判定手段７１ｉ）により水素が漏れていると判断した場合は、図１に示すように、その信号が報知手段８に送られて、この報知手段８により水素が漏れていることが報知される。さらに、ＥＣＵ７によりインタンク弁１１ａと遮断弁１２ａに水素の供給を遮断させる水素遮断信号が送られて、これらの弁１１ａ，１２ａが閉じられる。

【００３５】以上によれば、本実施形態において、次のような効果を得ることができる。算出された圧力降下量、すなわち水素が水素供給路１２を漏れずに通ってきたときの値を表わす圧力降下量と実際の値を示す検出された圧力降下量を比較するので、検出された圧力降下量と算出された圧力降下量との差が所定値以上である場合に水素が漏れていると判断することができる。また、このように燃料電池２の総水素量から算出した圧力降下量と実際の圧力降下量を比較することにより、従来のように弁を閉じるための設定値を燃料電池の最大消費量に対応する圧力降下量等よりも高めに設定する必要がないので、わずかな水素漏れを精度良く検知することができる。

【００３６】以上、本発明は、前記実施形態に限定されることなく、様々な形態で実施される。本実施形態では、燃料電池２の消費水素量を設定するために、開度センサ６による指令値を利用する構造としたが、本発明はこれに限定されるものではない。たとえば、燃料電池から取り出される電流値および電圧値をセンサにより検出して、この検出値に基づいて燃料電池の消費水素量を算出するようにしてもよい。本実施形態では、パージ水素量を第３のセンサ５で検出したパージ弁１２ｆの開放時間に基づいて算出するようにしたが、本発明はこれに限定されるもではない。たとえば、パージ水素量を、パージ指令時に所定時間パージ弁を開放するといったパージ指令値に基づいて算出してもよく、パージ弁から排出される水素量を直接検出して、その検出値に基づいて算出してもよい。本実施形態では、燃料電池から排出されるパージ水素量および減耗水素量を用いて総水素量を算出

しているが、本発明はこれに限定されず、たとえば、パージ水素、減耗水素のどちらかが微量で無視できる場合はどちらか片方の未利用水素量を用いて総水素量を算出してもよい。

【００３７】

【発明の効果】請求項１に記載の発明によれば、算出された圧力降下量と実際の値を示す検出された圧力降下量を比較することで、従来のように弁を閉じるための設定値を燃料電池の最大消費量に対応する流量もしくは圧力降下量よりも高めに設定する必要がないので、わずかな水素漏れを精度良く検知することができる。

【００３８】請求項２に記載の発明によれば、請求項１に記載の発明による効果に加え、たとえば、未利用の水素量を燃料電池内の減耗水素量とパージ水素量に分けて算出するため、わずかな水素漏れをより精度良く検知することができる。

【００３９】請求項３に記載の発明によれば、請求項１または請求項２に記載の発明による効果に加え、たとえば、総水素量が水素供給路内の水素の圧力と温度に応じて補正されるので、わずかな水素漏れをより精度良く検知することができる。

【００４０】請求項４に記載の発明によれば、算出された圧力降下量と実際の値を示す検出された圧力降下量を比較することで、従来のように弁を閉じるための設定値を高めにする必要がないので、わずかなガス漏れを精度良く検知することができる。

【００４１】請求項５に記載の発明によれば、請求項４に記載の発明による効果と同様に、わずかなガス漏れを精度良く検知することができる。

【図面の簡単な説明】

【図１】本実施形態に係る燃料供給装置の構成を示す構成図である。

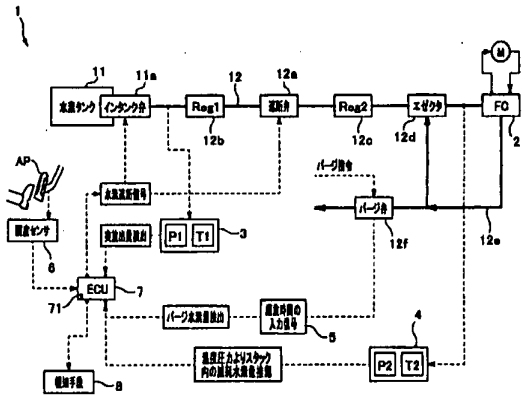
【図２】本実施形態に係る水素漏れ判断手段を示すブロック図である。

【図３】本実施形態に係る漏れ判定手段の判定方法の概念を示す概念図である。

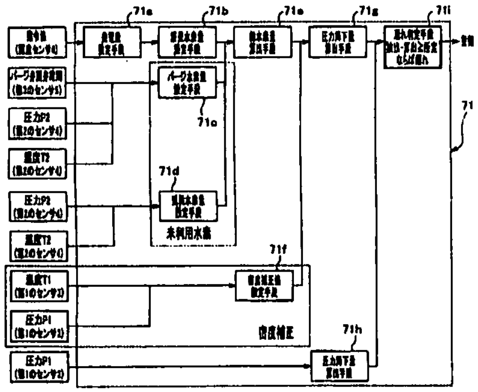
【符号の説明】

１	燃料供給装置
１１	水素タンク
１２	水素供給路
２	燃料電池
３	第１のセンサ（圧力降下量検出手段）
４	第２のセンサ
５	第３のセンサ
６	開度センサ
７	ＥＣＵ
７１	水素漏れ判断手段

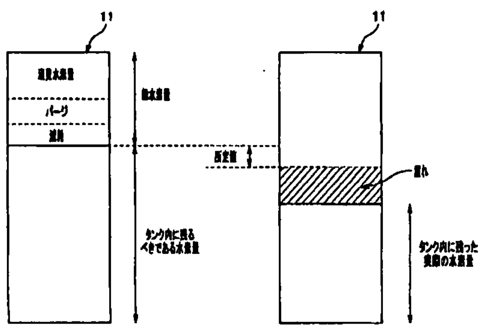
【図１】



【図2】


71a
71b
71e
71g
71i
71c
71d
71f
71h
71
圧力P2
温度T2
圧力P1
温度T1
未利用水素
密度補正
圧力降下量
算出手段

【図3】


11
11
パージ
所定値
漏れ
タンク内に残るべきである水素量
タンク内に残った実際の水素量